

Claims

1. A device for detecting the pattern of polynucleic acid hybridization to a surface, the device comprising:

(a) positioning means for receiving a nucleic acid chip and keeping the chip in a sampling position;

the nucleic acid chip being an object with a flat sample surface and an opposed surface that is joined to the sample surface by a thickness, with the sample surface having sequences of nucleic acids immobilized thereto, with each sequence being immobilized to a particular chip address;

(b) an optical filter that selectively transmits light;

(c) an electronic light detector array, the detector array comprising detector pixels, the detector pixels being sensors located at particular detector pixel addresses; and

(d) a light source that generates source light

wherein the sampling position is a position that places the sample surface of the chip in a well-defined spatial relationship relative to the electronic light detector array so that the source light that touches a chip address on the sample surface is substantially directed onto at least one detector pixel with an address that is correlated to the chip address.

2. The device of claim 1 wherein the chip address to detector pixel correlation is one-to-one, whereby the light touching a single chip address is directed to substantially one detector pixel.
3. The device of claim 1 wherein more than one detector pixel is correlated to one chip address.
4. The device of claim 1 wherein light leaving the sample surface of the chip passes through the chip thickness before reaching the detector pixels.
5. The device of claim 4 wherein the light leaving the sample surface of the chip passes through the optical filter.
6. The device of claim 5 comprising a mapping lens that changes the direction of light rays leaving the sample surface of the chip, wherein the mapping lens is located between the sample surface and the detector pixels.
7. The device of claim 6 wherein the mapping lens is a reducing lens.
8. The device of claim 6 wherein the mapping lens is a magnifying lens.

9. The device of claim 6 wherein the mapping lens comprises a means for collimating the light.
10. The device of claim 6 wherein the mapping lens and the optical filter are combined into one apparatus.
11. The device of claim 4 wherein the nucleic acids are DNA.
12. The device of claim 4 wherein the chip is made of quartz.
13. The device of claim 4 wherein the chip is made of glass.
14. The device of claim 4 wherein the chip is made of a light-transmissive plastic.
15. The device of claim 14 wherein the plastic is polystyrene.
16. The device of claim 4 comprising the chip, wherein the chip comprises the optical filter.
17. The device of claim 16 wherein the chip bottom surface is coated with an optical coating.
18. The device of claim 6 wherein the chip further comprises the mapping lens.

19. The device of claim 18 wherein the bottom surface of the chip comprises a curved surface that functions as the mapping lens.

20. The device of claim 5 wherein the chip is in direct physical contact with the filter.

21. The device of claim 20 wherein the bottom surface of the chip is in contact with the filter.

22. The device of claim 21 wherein the filter and the detector array are in direct physical contact.

23. The device of claim 17 wherein the chip is in direct physical contact with the electronic light detector array.

24. The device of claim 5 wherein the bottom surface of the chip is in direct physical contact with the filter.

25. The device of claim 4 wherein the detector array detector pixels are in direct physical contact with the optical filter.

26. The device of claim 25 wherein all of the detector array detector pixels are in direct physical contact with the optical filter.

27. A device for detecting the pattern of polynucleic acid hybridization to a surface, the device comprising:

(a) positioning means for receiving a nucleic acid chip and keeping the chip in a sampling position;

the nucleic acid chip being an object with a flat sample surface and an opposed surface that is joined to the sample surface by a thickness, with the sample surface having sequences of nucleic acids immobilized thereto, with each sequence being immobilized to a particular chip address; and

(b) an electronic light detector array, the detector array comprising detector pixels, the detector pixels being sensors located at particular detector pixel addresses;

wherein the sampling position places the sample surface of the chip at a well-defined position relative to the electronic light detector array so that source light from a light source that touches a chip address on the sample surface is substantially directed onto at least one detector pixel with an address that is correlated to the chip address.

28. The device of claim 27 wherein the chip address to detector pixel correlation is one-to-one.
29. The device of claim 27 wherein more than one detector pixel is correlated to one chip address.
30. The device of claim 27 wherein light leaving the sample surface of the chip passes through the chip thickness before reaching the detector pixels.
31. The device of claim 27 wherein the light leaving the sample surface of the chip passes through an optical filter.
32. The device of claim 31 wherein the optical filter allows substantially only light generated at the sample surface to pass to the detector.
33. The device of claim 32 wherein the optical filter substantially blocks the source light.
34. The device of claim 27 wherein the chip and the detector array are in direct physical contact.

35. The device of claim 34 wherein all wavelengths of light that touch the sample surface of the DNA chip are allowed to pass to the detector array.

36. The device of claim 35 wherein no optical filter is used in the light path between the sample surface and the detector array.

37. The device of claim 35 wherein all wavelengths of the source light are allowed to reach the detector pixels.

38. The device of claim 35 comprising a neutral density filter, the neutral density filter being placed in the light path between the sample surface and the detector array, and the neutral density filter being used to block some of the source light without filtering out any wavelengths of light.

39. The device of claim 27 wherein the position of a dark spot on the sample surface, the dark spot being a spot that substantially blocks the passage of light, is mapped directly onto the detector array.

40. The device of claim 27 wherein the light source is used to illuminate the sample surface so that light leaving the sample surface is projected onto the detector array so that a dark spot on the sample surface, the dark spot being a spot on the sample surface that blocks more light than

the surrounding sample surface, causes less light to be received by at least one detector pixel, whereby the address of the dark spot on the sample surface is detected.

41. A device for detecting the pattern of polynucleic acid hybridization to a surface, the device comprising:

(a) positioning means for receiving a nucleic acid chip and keeping the chip in a sampling position;

the nucleic acid chip being an object with a flat sample surface and an opposed surface that is joined to the sample surface by a thickness, with the sample surface having sequences of nucleic acids immobilized thereto, with each sequence being immobilized to a particular chip address; and

(b) an electronic light detector array, the detector array comprising detector pixels, the detector pixels being sensors located at particular detector pixel addresses;

wherein the sampling position places the sample surface of the chip at a well-defined position relative to the electronic light detector array so that light leaving a chip address is substantially directed onto at least one detector pixel with an address that is correlated to the chip address.

42. The device of claim 41 wherein the chip address to detector pixel correlation is one-to-one.



43. The device of claim 41 wherein more than one detector pixel is correlated to one chip address.

44. The device of claim 41 further including at least one optical lens, the optical lens being used to map an image of the sample surface onto the electronic light detector array is zero.

45. The device of claim 44 wherein the number of all optical lenses used to map an image of the sample surface onto the electronic light detector array is one.

46. The device of claim 44 wherein the number of all optical lenses used to map an image of the sample surface onto the electronic light detector array is two.

47. The device of claim 41 wherein light leaving the sample surface of the chip passes through the chip thickness before reaching the detector pixels.

48. The device of claim 41 wherein the light leaving the sample surface of the chip is generated by chemiluminescence.

49. The device of claim 41 wherein the light leaving the sample surface of the chip is generated by fluorescence.

50. The device of claim 41 wherein the light leaving the sample surface is generated by two-photon excitation.

51. The device of claim 41 wherein the light leaving the sample surface is generated by multi-photon excitation.

52. The device of claim 41 wherein the light leaving the sample surface is generated by fluorescence and polynucleic acids that attach to the sample surface cause a quenching of fluorescence.

53. The device of claim 52 wherein the light leaving the sample surface is generated by fluorescence and polynucleic acids that attach to the sample surface have attached molecules that cause a quenching of fluorescence.

54. The device of claim 41 wherein the light leaving the sample surface is generated by a light source that generates source light.

55. The device of claim 54 wherein the source light is light that is detectable by the human eye.

56. The device of claim 41 wherein the light leaving the sample surface is generated by a light source that generates source light and polynucleic acids that attach to the sample surface have attached molecules that cause a decrease of the intensity of the light that leaves the sample surface.

57. The device of claim 41 wherein the light leaving the sample surface of the chip passes through an optical filter.

58. The device of claim 57 wherein the optical filter allows substantially only light generated at the sample surface to pass to the detector.

59. The device of claim 58 wherein the optical filter substantially blocks the light that is not generated at the sample surface.

60. The device of claim 41 wherein the chip and the detector array are in direct physical contact.

61. The device of claim 34 wherein the chip comprises an optical filter.

62. The device of claim 34 wherein the chip further comprises a mapping lens.

63. The device of claim 41 wherein all wavelengths of light that touch the sample surface of the DNA chip are allowed to pass to the detector array.

64. The device of claim 63 wherein no optical filter is used in the light path between the sample surface and the detector array.

65. The device of claim 63 wherein all wavelengths of the source light are allowed to reach the detector pixels.

66. The device of claim 65 wherein the length of the light path is between 15 microns and 1 centimeter.

67. A system for imaging spots of polynucleic acid on a polynucleic acid chip, the system comprising:

- (a) light source means that emits source light;
- (b) light detector means, the light detector means including detector pixels;
- (c) holding means for holding the chip, the chip comprising a top sample surface and a bottom, the sample surface having addresses, the holding means being positioned relative to the light detector means so that light leaving a sample surface address is mapped onto at least one detector pixel;
- (d) electronic data processing means that processes electronic data from the chip;

(e) data transmitting means that transmits data from the electronic light detector array to the electronic data processing means; and

(f) the system having a sample light path, which is the light path that must be traveled by all of the light that leaves the sample surface and is detectable by the light detector means.

68. The system of claim 67, wherein every point of the sample light path has an index of refraction that is greater than 1.0.

69. The system of claim 68 wherein the sample light path is comprised of solid materials.

70. The system of claim 67 wherein the sample light path does not include an optical lens that magnifies the image of the sample surface.

71. The system of claim 67 wherein the sample light path does not include an optical lens that reduces the image of the sample surface.

72. The system of claim 67 wherein the sample light path is less than 1 centimeter.

73. The system of claim 67 wherein the sample light path is less than one millimeter.

74. The system of claim 67 wherein the sample light path is less than 200 microns.
75. The system of claim 67 wherein the sample light path is less than 75 microns.
76. The system of claim 67 wherein the sample light path is less than 35 microns.
77. The system of claim 67 wherein the sample light path is less than 15 microns.
78. A polynucleic acid chip, the chip having a top sample surface that has immobilized nucleic acid sequences attached thereto, and an opposed surface, the chip being made of a light-transmitting material.
79. The chip of claim 78 wherein the chip comprises an optical filter.
80. The chip of claim 79 wherein the filter consists of a coating on the opposed surface of the chip.
81. The chip of claim 80 wherein the optical coating allows passage of light wavelengths that are emitted by fluorescein but substantially blocks other light wavelengths in the range of 300-600 nanometers.

82. The chip of claim 79 wherein the chip comprises an optical lens.
83. The chip of claim 78 wherein the chip comprises an optical lens.
84. The chip of claim 83 wherein the focal length of the optical lens is in the range of 10-750 microns.
85. The chip of claim 83 wherein the focal length of the optical lens is in the range of 10-400 microns.
86. The chip of claim 83 wherein the focal length of the optical lens is in the range of 10-250 microns.
87. The chip of claim 83 wherein the focal length of the optical lens is in the range of 5-40 microns.

88. A method for detecting spots of polynucleic acid on a polynucleic acid chip, the method comprising the following steps:

- (a) loading a polynucleic acid chip in a holder,

(b) positioning the holder at a sampling position, the sampling position being a position relative to a light detector that establishes a sampling distance between the top sample surface of the chip and the light detector that allows light that emanates from a point approximately at the surface of the chip to travel along a short light path to the light detector, and

(c) using a detection means to detect the signal generated by the light detector.

89. The method of claim 88 wherein the short light path is less than four millimeters.

90. The method of claim 88 wherein the short light path is less than 200 microns.

91. The method of claim 88 wherein the light path is substantially linear.

92. The method of claim 89 comprising the steps of using a positioning means to bring the holder from a loading position to the sampling position.

93. The method of claim 92 wherein the positioning means comprises a sliding mechanism.

94. The method of claim 93 wherein the positioning means comprises a motor.



95. The method of claim 94 wherein a chip is loaded into the holder while the holder is in a loading position and a switch is activated to turn the motor on to slide the holder to the sampling position.

96. The method of claim 88 further comprising focusing steps, the focusing steps comprising:

- (i) moving the holder to a new position,
- (ii) using the light detector, the detection means, and a graphic display means to visualize the surface of the sample; and
- (iii) repeating steps (i) and (ii) until a sampling distance desired by a user is achieved.

97. The method of claim 96 wherein the focusing steps are automatically performed by a programmable computer.